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Original Research Article

Comparison of pressure support ventilation pro mode with manual assisted ventilation on emergence time, hemodynamics and ventilation mechanics during extubation after general anaesthesia: A randomized controlled trial

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Abstract

Background & Methods: The aim of the study is to Compare pressure support ventilation pro mode with manual assisted ventilation on emergence time, hemodynamics and ventilation mechanics during extubation after general anaesthesia. To our knowledge there is no study comparing pressure support ventilation with manual assisted ventilation in intubated patients during emergence and extubation. Although studies have shown favorable results for weaning of patients in ICU.

Results: Scor- The chi-square statistic is 6.2196. The p-value is .026443. The result is significant at $p < .05$. PLP - The chi-square statistic is 6.2787. The p-value is .049765. The result is not significant at $p < .05$.

Conclusion: The choice of ventilation strategies during GA is critical for optimizing patient outcomes and minimizing complications. Tailoring these strategies to individual patient characteristics -such as age, comorbidities, and type of surgery- ensures efficacy and safety. Large-scale RCTs should focus on diverse patient populations and incorporate advanced technologies to refine ventilation management.

Keywords: pressure, ventilation, hemodynamics, extubation & anaesthesia.

Study Design: Prospective Randomized Trial.

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Introduction

General anesthesia (GA) is a medical state induced to facilitate surgical procedures, ensuring the patient remains unconscious, immobile, and free from pain. The administration of GA involves a multifaceted approach, with ventilation strategies playing a pivotal role in the overall management of anesthesia. Adequate ventilation is crucial not only for the maintenance of normal physiological functions but also for the prevention of complications during and after surgery [1].

The primary goal of ventilation during GA is to ensure sufficient oxygen delivery and carbon dioxide removal [2]. Historically, traditional methods such as manual ventilation and the use of endotracheal tubes have been standard practices. However, advancements in anesthesia technology have led to the development of various ventilation strategies, including volume-controlled mechanical ventilation, pressure-controlled ventilation (PCV), and adaptive support ventilation [3]. Each of these methods presents unique advantages and limitations that can impact patient outcomes, particularly in high-risk populations such as those with respiratory comorbidities or in prolonged surgical procedures [4,5].

The importance of selecting an appropriate ventilation strategy cannot be overstated (Figure 1). Studies have shown that inadequate ventilation can lead to hypoxemia, hypercapnia, and even respiratory failure, resulting in increased morbidity and mortality rates [6]. Furthermore, the choice of ventilation strategy may influence intraoperative hemodynamics, the incidence of PPCs, and the duration of recovery [7]. For instance, studies have demonstrated that patients who receive protective lung ventilation (PLV) strategies, which are characterized by lower tidal volumes and optimal positive end-expiratory pressure (PEEP), exhibit improved respiratory outcomes compared to those receiving conventional ventilation techniques [8].

Manual assisted ventilation has been used for a long time during extubation after general anaesthesia. During emergence from anaesthesia hemodynamic derangements like tachycardia, hypertension and arrhythmias can occur. Coughing against manual breaths, bronchospasm and dyssynchronized assistance in ventilation can lead to rise in airway pressures and patient discomfort [9]. All these derangements are cradle for complications like adverse cardiac events, pulmonary edema, pneumothorax, delayed extubation and awareness. Pressure support ventilation decreases the work of breathing by providing the patient with positive airway pressure during the inspiratory phase [10]. By synchronizing pressure support ventilation and monitoring of airway mechanics we can decrease several of the above mentioned adverse events during weaning. Pressure support ventilation is already being used in intensive care units to improve patient-ventilator synchrony and facilitate weaning. An anaesthesia machine that employs this mode of ventilation can now be used to allow smooth inductions, emergence, and maintenance of anesthesia while the patient is mechanically ventilated [11].

Psv pro mode can allow the patient to take spontaneous breaths, when appropriate, without fighting the ventilator [12]. In psv mode the patient imposes his or her respiratory rate and inspiratory time. One of the potential advantages of psv is a better patient-ventilator synchrony and the associated decrease in work of breathing and improved breathing comfort. That's why psv is used to enable a smooth transition between apnea and spontaneous

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ventilation in anaesthesia. Manual assisted breathing is often used during general anaesthesia, but may provide less effective gas exchange than pressure support mode of ventilation [13]. Hypercapnic acidosis and an increased work of breathing can occur during general anaesthesia both in healthy and non-healthy patients.

Objective of the study: We are proposing a randomized controlled double blinded study to compare pressure support ventilation pro mode with manual assisted ventilation on emergence time, hemodynamics and ventilation mechanics during extubation after general anaesthesia.

Material and Methods

Total 100 Sample size was based on previous studies, Place of study: gian sagar medical college and hospital for six months.

Inclusion and exclusion criteria: 100 ASA physical status 1 and 2 patients scheduled for elective surgery under general anaesthesia with endotracheal intubation and mechanical ventilation were included in this study. Exclusion criteria was emergency procedures, reactive airway diseases, obesity, hypertension.

Detail of procedure and safety measures for patient: General anaesthesia was induced according to standard protocol and patient intubated using endotracheal tube. During extubation nitrous oxide was stopped after last incision, isoflurane after dressing, laryngoscopy was done to see posterior pharyngeal wall movements and reversal was given. Monitoring included electrocardiography, heart rate, mean arterial blood pressure (MAP) (monitored noninvasively), pulse oximetry (spo2), end expiratory concentrations of carbon dioxide (PETCO2), VTE, peak airway pressures, breathing pattern and respiratory rate. Baseline readings were taken at the end of anaesthetic agent administration and then every minute till extubation.

Intended intervention: In PSV-group patients undergo PSV (inspiratory pressure level was set to obtain a tidal volume between 7–8 ml/kg and respiratory rate between 10–16 breaths /minute according to ETCO2 (35-40), inspiratory trigger was fixed at −2 cmh2o. In other group patient was assisted with intermittent manual ventilations after registering spontaneous breaths on ETCO2 and ventilator monitors. Although the staff members who collected data during surgery were aware of the group assignments, end points assessors were unaware of these assignments throughout the study. At the end of surgery, the extubation time was from stopping of anaesthetic agent administration till removal of endotracheal tube and the emergence time was defined as the time to obtain a 10 point score on a five questions test. Each of the following items; 1) name 2) date of surgery; 3) day of the week; 4) address of the patient; 5) month of birth. Simple addition, will be done scored 0 (no response), 1 (inexplicit response) or 2 (good response).

Statistical analysis: In operating room, patients were allocated randomly into two groups (MAV and PSV) using computer based randomization algorithm. Following the intention-to-treat principle, all randomized patients were included in these analyses. Continuous variables were summarized as means ± SD or median and interquartile ranges (IQR) when appropriate and categorical variables as absolute frequencies and percentages. The Chi-squared, Student's

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t and Wilcoxon tests were used to compare the two groups regarding categorical and continuous variables, respectively. In order to evaluate the respiratory parameters variations along time, a two-way repeated measure analysis of variance (ANOVA) was performed. The significance level was 0.05. The statistical package used for all analyses was the SPSS; version 11.0. Collected data was analyzed by SPSS with the help of a statistician.

Result

Table No. 1:HR

		Mean	Std. Deviation	Minimum	Maximum	P Value
PSV	HR0	85.8100	13.06603	61.00	110.00	.03511
	HR1	92.0600	18.32469	59.00	120.00	
	HR2	101.4124	14.84977	72.00	124.00	
	HR3	99.88	11.360	77	122	
	HR4	93.53	8.073	80	108	
	HR5	93.52	9.631	72	106	
	HR6	94.00	7.385	84	99	
	HR7	87.00	5.345	82	92	
	HR8	90.50	3.742	87	94	
	HR9	90.50	1.604	89	92	
	HR10	94.00	0.000	94	94	
Spont	HR0	91.7700	13.83076	70.00	127.00	
	HR1	97.0000	14.52827	73.00	128.00	
	HR2	102.2209	14.70446	78.00	128.00	
	HR3	79.2700	42.31122	0.00	130.00	
	HR4	65.9600	49.01225	0.00	126.00	
	HR5	97.55	19.397	72	129	
	HR6	86.10	7.965	75	93	
	HR7	86.00	7.483	80	94	
	HR8	0.0000	0.00000	0.00	0.00	
	HR9	0.0000	0.00000	0.00	0.00	
	HR10	0.0000	0.00000	0.00	0.00	

The chi-square statistic is 0.3923. The p-value is .03511. The result is significant at $p < .05$.

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Table No. 2:MAP

		Mean	Std. Deviation	Minimum	Maximum	P Value
PSV	MAP0	95.5700	9.73721	73.00	114.00	.041766
	MAP1	102.2200	13.00783	77.00	127.00	
	MAP2	106.2900	12.30282	78.00	137.00	
	MAP3	107.13	13.601	71	135	
	MAP4	106.43	10.127	85	120	
	MAP5	103.93	10.110	82	116	
	MAP6	99.00	13.538	81	111	
	MAP7	102.00	8.552	94	110	
	MAP8	93.00	1.069	92	94	
	MAP9	93.50	.535	93	94	
	MAP10	92.00	0.000	92	92	
Spont	MAP0	99.0099	12.02206	71.00	120.00	
	MAP1	103.7228	12.55637	75.00	120.00	
	MAP2	104.5172	11.54250	82.00	119.00	
	MAP3	107.2222	12.57875	83.00	125.00	
	MAP4	107.1791	9.61836	86.00	123.00	
	MAP5	111.42	6.603	102	124	
	MAP6	111.30	4.029	108	117	
	MAP7	112.57	10.690	104	124	
	MAP8					
	MAP9					
	MAP10					

The chi-square statistic is 4.0152. The p-value is .041766. The result is significant at $p < .05$.

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Table No. 3:SPO

		Mean	Std. Deviation	Minimum	Maximum	P Value
PSV	SPO0	99.0800	.80000	97.00	100.00	.840292
	SPO1	99.2200	.59595	97.00	100.00	
	SPO2	99.3000	.59459	98.00	100.00	
	SPO3	99.20	.563	98	100	
	SPO4	98.81	.680	98	100	
	SPO5	99.27	.691	98	100	
	SPO6	98.67	.492	98	99	
	SPO7	99.00	0.000	99	99	
	SPO8	99.00	0.000	99	99	
	SPO9	99.50	.535	99	100	
	SPO10	100.00	0.000	100	100	
Spont	SPO0	98.9700	.74475	98.00	100.00	
	SPO1	98.9100	1.11096	94.00	100.00	
	SPO2	99.3023	.70410	97.00	100.00	
	SPO3	99.2625	.58987	98.00	100.00	
	SPO4	99.2727	.73475	98.00	100.00	
	SPO5	99.08	.547	98	100	
	SPO6	99.30	.483	99	100	
	SPO7	99.43	.535	99	100	

The chi-square statistic is 0.0406. The *p*-value is .840292. The result is *not* significant at $p < .05$.

Table No. 4:ETCO

		Mean	Std. Deviation	Minimum	Maximum	P Value
PSV	ETCO0	35.2400	2.98522	28.00	40.00	.697806
	ETCO1	35.0500	3.12492	28.00	40.00	
	ETCO2	35.1800	3.44474	27.00	39.00	
	ETCO3	35.41	3.347	26	40	
	ETCO4	36.36	2.058	33	39	
	ETCO5	36.33	2.537	32	40	
	ETCO6	35.00	3.075	31	38	
	ETCO7	39.00	0.000	39	39	
	ETCO8	35.50	3.742	32	39	
	ETCO9	34.00	4.276	30	38	
	ETCO0	33.7300	3.27789	28.00	40.00	

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Spont	ETCO1	35.0000	3.36050	29.00	40.00	
	ETCO2	33.8837	4.35598	24.00	40.00	
	ETCO3	34.1375	4.06200	20.00	40.00	
	ETCO4	34.1667	3.95196	28.00	40.00	
	ETCO5	32.00	5.711	21	37	
	ETCO6	35.20	3.615	30	38	
	ETCO7	32.86	6.414	26	38	

The chi-square statistic is 0.1508. The *p*-value is .697806. The result is *not* significant at $p < .05$.

Table No. 5:PAP

		Mean	Std. Deviation	Minimum	Maximum	P Value
PSV	PAP0	20.4400	4.12756	12.00	29.00	.000754
	PAP1	18.2000	4.57706	10.00	29.00	
	PAP2	15.8300	4.51049	8.00	26.00	
	PAP3	12.08	3.558	5	22	
	PAP4	11.62	4.286	8	24	
	PAP5	11.50	3.767	5	16	
	PAP6	13.50	4.705	8	18	
	PAP7	16.00	2.138	14	18	
	PAP8	10.00	0.000	10	10	
	PAP9	9.00	1.069	8	10	
	PAP10	8.00	0.000	8	8	
Spont	PAP0	19.5200	4.09848	12.00	28.00	
	PAP1	18.6000	6.79126	2.00	29.00	
	PAP2	17.9884	5.56775	8.00	29.00	
	PAP3	16.9250	4.92417	8.00	27.00	
	PAP4	13.9091	4.96054	7.00	24.00	
	PAP5	12.95	6.055	3	21	
	PAP6	15.10	4.977	8	19	
	PAP7	15.86	6.414	9	21	
	PAP8					
	PAP9					
	PAP10					

The chi-square statistic is 11.3516. The p-value is .000754. The result is significant at $p < .05$.

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Table No. 6:RR

		Mean	Std. Deviation	Minimum	Maximum	P Value
PSV	RR0	15.8900	3.98709	8.00	22.00	.79525
	RR1	16.4900	3.72948	10.00	25.00	
	RR2	17.0100	4.32165	8.00	25.00	
	RR3	17.45	3.778	10	27	
	RR4	18.02	3.061	14	25	
	RR5	18.33	2.832	16	24	
	RR6	19.33	1.775	17	21	
	RR7	20.00	0.000	20	20	
	RR8	15.00	3.207	12	18	
	RR9	15.00	0.000	15	15	
Spont	RR0	13.6900	3.31112	8.00	20.00	
	RR1	14.3200	3.76018	6.00	23.00	
	RR2	15.6744	5.76285	7.00	31.00	
	RR3	15.2375	4.18025	10.00	25.00	
	RR4	16.2879	3.84614	10.00	25.00	
	RR5	17.05	4.527	12	26	
	RR6	15.90	6.280	12	25	
	RR7	10.00	0.000	10	10	

The chi-square statistic is 0.0673. The p-value is .79525. The result is not significant at $p < .05$.

Table No. 7:PLP

		Mean	Std. Deviation	Minimum	Maximum	P Value
PSV	PLP0	8.9500	2.20365	6.00	15.00	.049765
	PLP1	8.6800	2.83513	5.00	17.00	
	PLP2	7.6800	2.84225	2.00	16.00	
	PLP3	6.37	2.058	3	13	
	PLP4	6.02	1.751	4	10	
	PLP5	5.47	2.097	2	9	
	PLP6	7.33	2.146	5	10	
	PLP7	6.00	1.069	5	7	
	PLP8	5.50	.535	5	6	
	PLP9	3.00	1.069	2	4	
	PLP0	9.8100	3.58644	4.00	20.00	
	PLP1	8.3700	3.98141	1.00	17.00	

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Spont	PLP2	8.5581	3.88846	3.00	17.00	
	PLP3	8.8500	4.48373	2.00	20.00	
	PLP4	5.9545	3.11044	2.00	15.00	
	PLP5	5.05	2.471	2	10	
	PLP6	4.00	.816	3	5	
	PLP7	5.86	2.673	3	8	

The chi-square statistic is 6.2787. The p-value is .049765. The result is not significant at $p < .05$.

Table No. 8:Scor

		Mean	Std. Deviation	Minimum	Maximum	P Value
PSV	scor ext	5.9600	1.65706	2.00	8.00	.026443
	scor1	7.3800	2.19632	2.00	10.00	
	scor2	8.1053	2.16382	2.00	10.00	
	scor3	7.74	1.534	6	10	
	scor4	9.00	1.017	8	10	
	scor5	9.07	1.033	8	10	
	scor6	10.00	0.000	10	10	
Spont						
	scor2	4.3200	2.64720	0.00	8.00	
	scor3	6.1200	2.42579	2.00	10.00	
	scor4	7.8261	2.29001	2.00	10.00	
	scor5	9.0182	1.67211	6.00	10.00	
	scor6	8.0000	1.85164	6.00	10.00	
	scor7	8.67	1.000	8	10	
	scor8	10.00	0.000	10	10	

The chi-square statistic is 6.2196. The p-value is .026443. The result is significant at $p < .05$.

Discussion

Patients can interact with the ventilator and modify the breathing output to suit their unique and immediate demands through computer-driven or automated weaning. The PSV in MRV is determined by the ventilator's measurement of RR [14]. According to our study there was significant difference in control of HR, MAP, PAP, PLP which was better in PSV group, there was no significant difference in Spo2, ETCo2 and RR in two groups. There was significant difference in mean value of 10 point score between two groups. The automatic algorithm

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selected pressure support levels greater than those of the staff determined by the RR/VT value (less than 80 L) in the manual group in order to maintain the goal RR at 15 bpm.

In a multi-center randomized experiment, Lellouche and colleagues demonstrated that, in contrast to a physician-controlled weaning procedure, a computer-driven weaning protocol for patients admitted to the intensive care unit (ICU) for longer than 24 hours decreased the length of stay in the ICU and the duration of mechanical breathing. In contrast to this study, a recently published randomized controlled trial by Rose and colleagues [15] revealed no benefit in employing automatic weaning in a patient sample that was mostly composed of surgical and trauma patients. Only post-operative patients were included in our procedure; these patients have less respiratory conditions and comorbidities, and hence are easier to wean and extubate from a mechanical ventilator.

The number of patients who experienced problems throughout the automatic weaning process is one factor to take into account. In the automatic mode, 15 patients experienced complications, compared to just four in the manual group. This difference is significant ($p = 0.05$). One patient refused to complete the trial, and three patients in the manual group experienced hemodynamic instability (such as septic shock, hemorrhagic shock, cardiogenic shock, or severe arrhythmias). Five patients in the automatic group experienced difficulties from hemodynamic instability, one patient declined to continue the trial, and nine patients experienced complications connected to the ventilator and the automatic weaning method. Six of the patients maintained a high level of pressure support, reaching the maximum pressure support of 25 cm H2O and remaining there. Three of the patients were conscious and breathing normally, but their pressure support did not drop as anticipated to lower values of five to seven for the extubation, despite the fact that it did not reach the maximum level.

In a great majority of instances, when patients are assessed to be ready for weaning, spontaneous breathing is encouraged to avoid the use of excessive sedation. Faster liberation from mechanical ventilation is likely to reduce the risk of ventilator associated pneumonia. The mechanical ventilator must match the patient's respiratory demands without interfering. This will ensure patient comfort and reduce the work of breathing[16].

Chao et al found that more than 10% of patients admitted to a weaning centre exhibited patientventilator asynchrony.10 As a result; weaning was less successful and took longer time due to wasted diaphragmatic energy[17]. Successful ventilation requires optimisation of patient comfort, while at the same time providing adequate oxygenation and ventilation. Studies have shown that dyssynchrony is associated with a longer duration of mechanical ventilation.

Xirouchaki et al showed in their study that PAV+ is a safe and efficient ventilator mode that may support the majority of the critically ill patients meeting criteria for assisted ventilation[18]. They found that PAV+ increases the probability of remaining on assisted or unassisted spontaneous breathing, compared to PSV while it considerably reduces the incidence of patient–ventilator asynchronies. The limitation of this study was that all the patients included were placed on either of the group for a period of 48 hours.

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Study limitations

Similar studies can be done on large number of patients to get better results. Further studies are needed comparing ASA 2 and ASA 3 patients.

Conclusion

The choice of ventilation strategies during GA is critical for optimizing patient outcomes and minimizing complications. Tailoring these strategies to individual patient characteristics - such as age, comorbidities, and type of surgery- ensures efficacy and safety. Large-scale RCTs should focus on diverse patient populations and incorporate advanced technologies to refine ventilation management.

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